TITLE: *The world according to Ptolemy*
DATE: *A.D. 200*
AUTHOR: *Claudius Ptolemy*

DESCRIPTION: The early period of cartography, from 4,000 B.C. to A.D.200 culminates with the contributions of the famous Greek scholar named Claudius Ptolemy. Little is known personally of this pivotal man aside from the general period during which he was active ca. A.D. 90 to 168 (during the reigns of Hadrian and Antoninus Pius) and that he lived in, or near, Alexandria Egypt. During the second century, Alexandria was not only the richest city in the world, with regard to learned institutions and treasures of scholarship, but also the wealthiest commercial place on the earth. It was a place where seafaring people and caravans from all parts of the known world would use to congregate, thereby providing the opportunity to collect knowledge of far away lands and seas. In spite of such scant personal knowledge, Claudius Ptolemy's writings have had a greater influence on cartography, and on geography in general, than that of any other single figure in history.

Most probably Ptolemy did not enclose maps to his geographical study that he finalized around 150 CE. In fact the "*Geography*" (*Geographike Hyphegesis*) was an instruction on how to draw a map (cylindrical projection etc.). No Ptolemaic map survived or was handed down to later antiquity. The oldest world map ascribed to Ptolemy dates back to the year 1297. The map was produced and drawn by a team under the Byzantine monk Maximus Planudes (1260-1330) who worked in Constantinople at that time. The core question is now: what happened during around 1150 years after Ptolemy? Was there a still stand in the history of geography and cartography?

Ptolemaic World Map by Maximus Planudes, 1297,
Codex Seragliensis GI 57, Topkapı Museum, Istanbul

While Ptolemy is most frequently associated with geography and cartography, he also wrote important works in a number of other fields including astronomy, astrology, music and optics. He composed a *Table of Reigns*, a chronological list of Assyrian, Persian, Greek, and Roman sovereigns dating from Nabonasar to Antoninus Pius, a biographical history of kingship. His *Analemma* was mathematical description of a sphere projected on a plane, subsequently known as an "orthographic projection," which greatly simplified the study of *gnomonics*. His work entitled *Planisphærium* [the Planisphere], described a sphere projected on the equator, the eye being at the pole, a projection later known as "stereographic". But there are two treatises for which Ptolemy is most celebrated. The first of these treatises is his *Magale Syntaxis* (ca. A.D. 141), a composition dealing with astronomy and mathematics, more commonly known by its hybrid Greco-Arabic title, the *Almagest*, in which he lays down the foundation of trigonometry and sets forth his view of the universe. Here he explains his belief that the earth is a stationary sphere, at the center of the universe, which revolves about it daily. While his proofs of the sphericity of the earth are still accepted today as valid, Ptolemy rejected the theory of the rotation of the earth about its axis as being absurd.

Ptolemy's approach to geography was strictly scientific and impersonal. He was interested in the earth, all of it, not just the habitable part, and tried to fit it into a scheme of the universe where it belonged. He was also interested in the relationships between the earth and the sun, the earth and the moon, in scientific cause and effect of climate; and above all, he was concerned with a scientifically accurate portrayal of the spherical earth in a convenient readable form. More than any one of the ancients, Claudius Ptolemy succeeded in establishing the elements and form of scientific cartography. This he did through his second great treatise, *Geographike Syntaxis*, called by him, "*the geographical guide to the making of maps*", and, in later centuries, shortened to simply *Geographia*, or (incorrectly) *Cosmographia*. This work is actually the first general atlas of the world to have survived, rather than a "Geography" with a long textual introduction to the subject of cartography. Here for the first time are documented the duties and responsibilities of the mapmaker, his limitations, and the nature of the materials he was to work with. This single treatise remained the standard work on geographical theory throughout the Middle Ages, was not superseded as such with the 16th century, and constitutes one of the fundamental tenants of modern geodesy.

Ptolemy's *Geography*, written AD ca. 150, had a profound impact on later science and culture. Its theoretical chapters describing the simple and the modified conical map projections (Ptolemy's first and second projections), its coordinate lists with more than 8,000 toponyms of the known *oecumene* [known inhabited world], and the atlas, consisting of a map of


noctialis qnqꝫ:taliũ eſt per meroen quattuor &
ſemis cum tercia. Vnde rationẽ habet ad ipſuꝫ
quã triginta ab uigiti & nouẽ qualium ẽ eqnoc
tialis qnqꝫtaliũ ẽ p ſienẽ quattuor & ſemis cũ
duodecia. Vnde rationẽ hꝫ ad eum quã ſexagin
ta ab qnquagita & qnque:hoc ẽ quã duodecim
ad undeci.qualium ẽ eqnoctialis qnque:taliuꝫ
eſt p rhodum quattuor. Vnde ratiõẽ habꝫ ad
ipm epitetarti:qualium ẽ eqnoctialis qnque ta
lium eſt p thulen duo cum quarta. Vnde ratio
nem hꝫ ad ipm quã uiginti ad nouem.

COSMOGRAPHIAE ALAV
DII PTOLEMAEI LIBER
SECVNDVS INCIPIT.

Eiuſdẽ tractatꝰ expoſitionẽ habẽs plage magis
occidẽtalis europe iuxta has ꝓuincias ſeu ſatra
pias Britaniã Hiſpniã Galliã Germaniẽ Rhe
tiã uidelicos noricũ pãnoniã illyricos atq; dal-
Ve ad uniuerſalem coſmograꝓhiæ
deſcriptionẽ reqrũtur:& que ipius
emendatio iuxta noticiã certioris
hiſtorie fuerit circa cognitũ nobis
orbẽ.hoc ẽ circa noſtrã habitat ilẽ
que ue ꝓportio dimenſionũ locorum habeti de
beat.que ue forma ut q̃ maxie poſſibile ſit ſimi
litudo ſeruet:quis ne ideſcribẽdo modus ſit af
ſumẽdus nũc uſq; ꝓnotatũ ſit.Deinceps uero i
cipiendũ ẽ ꝑticularius hec tractare:id ꝓpter
tes quod deſcriptiones locorũ longitudis ſ mul
& latitudis que magis explorata fuerunt exſti
mande ſunt ueritati q̃ maxie innitt ob cõtinuã

Ptolemy's instructions for drawing his conical projection (the simpler of the two he recommended) are supplemented by this diagram in the 1477 Bologna edition of his *Geographia*.

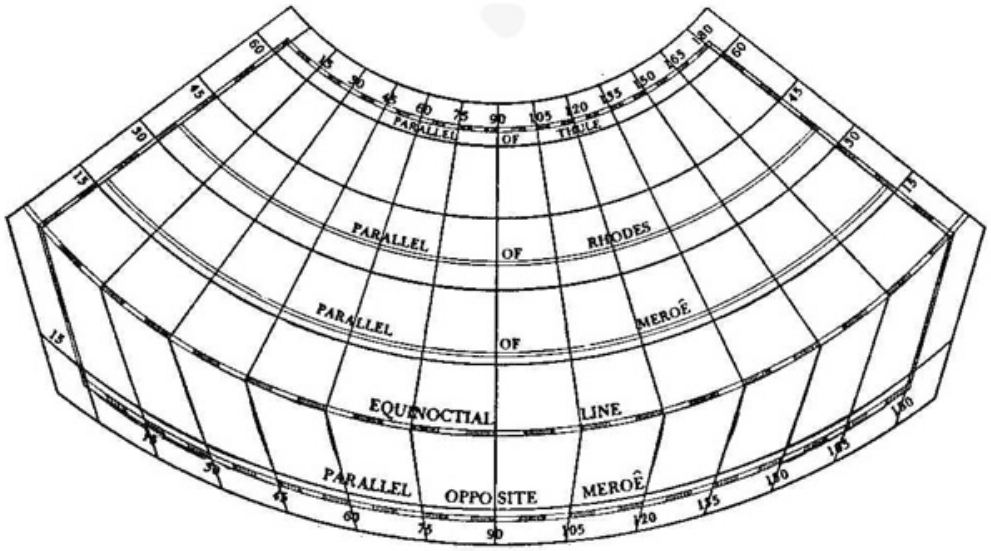
the world and twenty-six regional maps influenced the representation of the world and cartography until the 18th century. Although no original manuscript of this text has survived the ravages of time, several manuscript copies, dating from the closing centuries of the Byzantine Empire (ca. 11th century), still exist. These Byzantine copies of the *Geographia* are comprised of eight "Books" which Ptolemy introduces by supplying two very influential definitions - that of *chorography* and *geography*. He defines *chorography* as being selective and regional in approach, "*even dealing with the smallest conceivable localities, such as harbors, farms, villages, river courses, and the like*". *Geography*, he said, differs from *chorography* in that it deals with "*a representation in picture of the whole known world together with the phenomena that are contained therein*". As he proceeds to elaborate his definition of geography, it becomes apparent that Ptolemy conceived that the primary function of geography was "mapmaking", and that, to him, geography was synonymous with cartography. "*It is the prerogative of Geography,*" he said, "*to show the known habitable earth as a unit in itself, how it is situated and what is its nature; and it deals with those features likely to be mentioned in a general description of the earth, such as larger towns and great cities, the mountain ranges and the principle rivers.*" No divergence from these fundamental matters should be made, except for "*features worthy of special note on account of their beauty.*" Having thus introduced an elastic clause into an otherwise rigid geographical code Ptolemy went on to elaborate the task of the cartographer, which is to survey the world "*in its just proportions,*" that is, to scale. Cartography is not an artistic endeavor according to the Greek scholar, but should be concerned with the relation of distance and direction, and with the important features of the earth's surface that can be indicated by plain lines and simple notations (enough to indicate general features and fix positions).

For these and other reasons, Ptolemy knew mathematics to be an important part of cartography. "*It is the great and exquisite accomplishment of mathematics to show all these things to the human intelligence.*" With the aid of astronomy and mathematics, Ptolemy concluded, the earth could be mapped as accurately as the heavens had been charted. In cartography, said Ptolemy, one must contemplate the shape and size of the entire earth. Its position under the heavens is extremely important, for in order to describe any given part of the world one must know under what parallel of the celestial sphere it is located. Otherwise how can one determine the length of its days and nights, the stars which are fixed overhead, the stars which appear nightly over the horizon and the stars which never rise above the horizon at all. All such data must be considered as important to the study and mapping of the world.

The first Book of the *Geographia* is devoted primarily to theoretical principles, including a discussion of globe construction, the description of two map projections, and an extended, through amicable, criticism of his primary source, Marinus of Tyre, "the latest of the geographers of our time". Marinus, who flourished about A.D. 120, exerted considerable influence on the development of mapmaking. He seems to have studied and made astronomical observations in Tyre, the oldest and largest city of Phoenicia, which, even at that late date, maintained important commercial relations with remote parts of the world. This 'tutor' of Ptolemy had read nearly all of the historians before him and had corrected many of their errors (presumable errors relating to the location of places as contained in travelers' itineraries). He had, moreover, edited and revised his own geographic maps, of which at least two editions had been published before Ptolemy saw them. The final drafts were nearly free from defects and his text, which we know of only through Ptolemy, was so reliable in Ptolemy's estimation that "*it would seem to be*

enough for us to describe the earth on which we dwell from his commentaries alone, without other investigations." According to Ptolemy, the most significant feature of the maps of Marinus was the growth of the habitable world and the changed attitude toward the uninhabited parts. Marinus was a good man in Ptolemy's estimation but he lacked the critical eye and allowed himself to be led astray in his scientific investigations. According to Ptolemy, even Marinus had made mistakes, either because he had consulted *"too many conflicting volumes, all disagreeing,"* or because he had never completed the final revision of his map. Whichever it was, the map needed correcting - by Ptolemy, of course. However, Marinus' treatise on geography, with its maps, should still be ranked among the most important of the lost documents of the ancients, if for no other reason than that it was the foundation upon which Claudius Ptolemy built.

In another chapter in Book I, Ptolemy wrote that there are two ways of making a portrait of the world: one is to reproduce it on a sphere, and the other is to draw it on a plane surface. Each method has its advantages and disadvantages. *"When the earth is delineated on a sphere, it has a shape like its own, nor is there any need of altering [it] at all."* However, it is not easy to provide enough space on a globe for all of the details which should be included on it; moreover, if it is large enough to contain everything that should be drawn on it, the globe would be too large for the eye to encompass. Ptolemy then continues to give specific instructions on how to construct a globe properly.



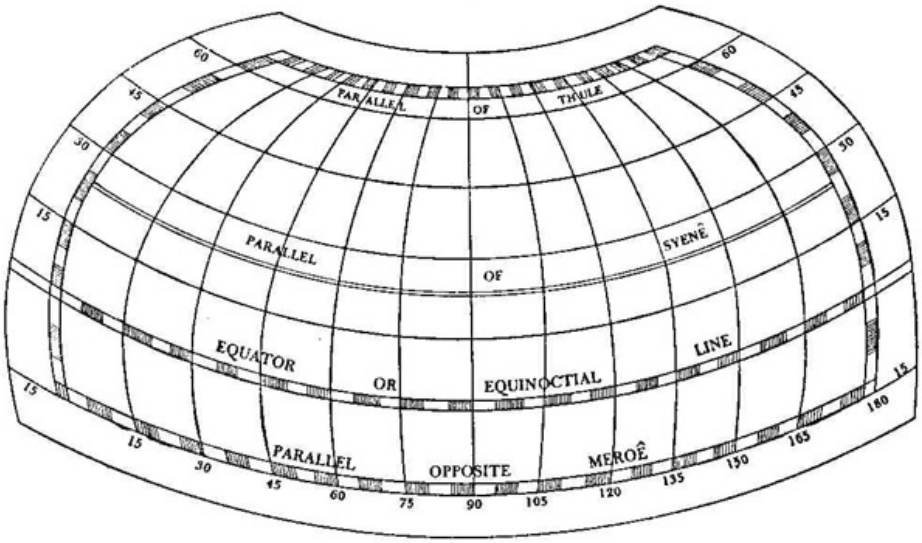
A reconstruction of Ptolemy's conic projection, suggested for the construction of a map of the habitable world, from Brown.

If the second method of drawing the earth is used, that is, if the spherical earth is projected onto a plane surface, certain adjustments are obviously necessary. Marinus had given this matter considerable thought, rejecting all previously devised methods of obtaining congruity on a flat map; yet, according to Ptolemy he had finally selected the least satisfactory method of solving the problem. Marinus had laid out a grid of strait lines equidistant from one another for both his parallels of latitude and meridians of longitude. This was contrary to both truth and appearance, and the resulting map was badly distorted with respect to distance and direction, for if the eye is fixed on the center of the quadrant of the sphere which we take to be our inhabited world, it is readily seen that the meridians curve toward the North Pole and that the parallels, though they are

equally spaced on the sphere, give the impression of being closer together near the poles. Ptolemy was well aware that it would be desirable to retain a semblance of spherical proportions on his flat map, but at the same time he decided to be practical about it. To avoid, or at least to lessen these errors by Marinus, Ptolemy proposed to employ what is now called a "conical projection", i.e., to project the map, with equidistant parallels, on a conical surface developed around the axis of the earth, and passing through the parallels of *Rhodes* and *Thule (see illustration above)*. When such a conical surface is extended on a plane, a network with circular parallels and rectilinear, converging meridians arise. Lest the proportions of certain parts of the mapped territory should be too much deformed, only the northern or the southern hemispheres should be laid down on the same map by this projection, which is consequently inconvenient for maps embracing the whole earth. However, Ptolemy rigorously applies the conical projection only to the northern part of his map of the world. To represent the known parts of the southern hemisphere on the same sheet, he describes an arc of a circle parallel to the equator, and at the same distance to the south of it, as *Meroe [Mæroe]* is to the north, and then divides this arc in parts of the same number and size, as on the *Parallel of Meroe*. The network is then obtained by joining the intersections to corresponding points on the equator.

Ptolemy's exhaustive criticism of the imperfect methods of drawing maps adopted by Marinus would lead to the expectation that he himself would have used some of his own recommended projections in constructing his maps. But such was not the case. Because while Ptolemy employs his conical projection in his first general world map, for the remaining twenty-six special regional maps he uses the *rectangular* projection of Marinus with due observance of the ratio between the longitude and latitude at the base of the map. This inconsistency seems to have astonished his publishers in the 15th and 16th centuries. With one exception (an Italian translation by Berlinghieri), every editor of Ptolemy's *Geographia* has published, not the original maps, but a modification of them by Nicolaus Germanus (Donis), who, with praiseworthy exactness and without any further alterations, reproduced the originals, on a projection with rectilinear, equidistant parallels and meridians converging towards the poles.

Book II of the *Geographia* opens with a prologue "of the particular descriptions", which is to say, the maps he was about to present, and a general statement of his mapmaking policy. There is also an introduction to data collection, evaluation, preparations for drawing, how and in what order to mark boundaries, and how to use the appended tables. Books II-VI and the first four chapters of Book VII are devoted to a complete catalogue of some 8,000 inhabited localities laid down in the twenty-six special maps of the geography. For every place-name, estuaries sources, mountains, promontories, peninsulas, etc., mentioned in the catalogue/table, latitude and longitude (in degrees) is given. It is an exception when geographical or descriptive remarks are added to this bare enumeration of names. What is remarkable and president-setting is the organization of these tables. Unlike Marinus who listed longitude on one page and latitude on another, Ptolemy began the tradition of listing the positional coordinates together and in a usable system that was practical to follow.



Ptolemy's modified spherical projection of the world.
While giving a superior likeness to the earth's surface on a sheet of paper, and preferable to the conic projection, Ptolemy thought it more difficult.

The latitude and longitude assigned to well-known places were fairly accurate since the traditional accounts concerning them agreed and more exacting measurements/observations had been taken; but the places that were little known, or about which there was considerable uncertainty, presented a major problem to geographers like Ptolemy. When traveling overland it is usually necessary to diverge from a straight line course in order to avoid inevitable land-barriers; and at sea, where winds are changeable, the speed of a vessel varies considerably, making it difficult to estimate over-water distances with any degree of accuracy. Nevertheless Ptolemy concluded that the most reliable way of determining distances was by astronomical observation, and by no other method could one expect to fix positions accurately. Traditional information regarding distances should be subordinated, especially the primitive sort, for tradition varies from time to time, and if it must enter into the making of maps at all, it is expedient to compare the records of the ancient past with newer records, "deciding what is credible and what is incredible". Therefore if a geographer were obliged to fall back on the reports of travelers, he should exercise some discrimination in his choice of authorities. Finally, Ptolemy thought, about all one could do was to locate unfamiliar places as accurately as possible with reference to well-known places, in as much as it is advisable on a map of the entire world to assign a definite position to every known place, regardless of how little is known about it. This Ptolemy did in marginal notations, leaving spaces for any necessary corrections.

The fifth chapter of Book VII contains a description of the map of the world, together with an enumeration of the oceans and of the more important bays and islands. The Indian Ocean, which is assumed to be bordered on the south by an unknown continent, uniting southern Africa with eastern Asia, is stated to be the largest sea surrounded by land. The Atlantic Ocean is not even mentioned among the seas. It is remarkable that such questions never seemed to have occurred to Ptolemy, as: What is there to be found beyond *Serica* and *Sinarum Situs*? What could be found to the north of

Thule, or to the south of *Agysimba* and *Cape Prasum*: Where would you arrive if you sailed westward from the *Fortunate Islands*?

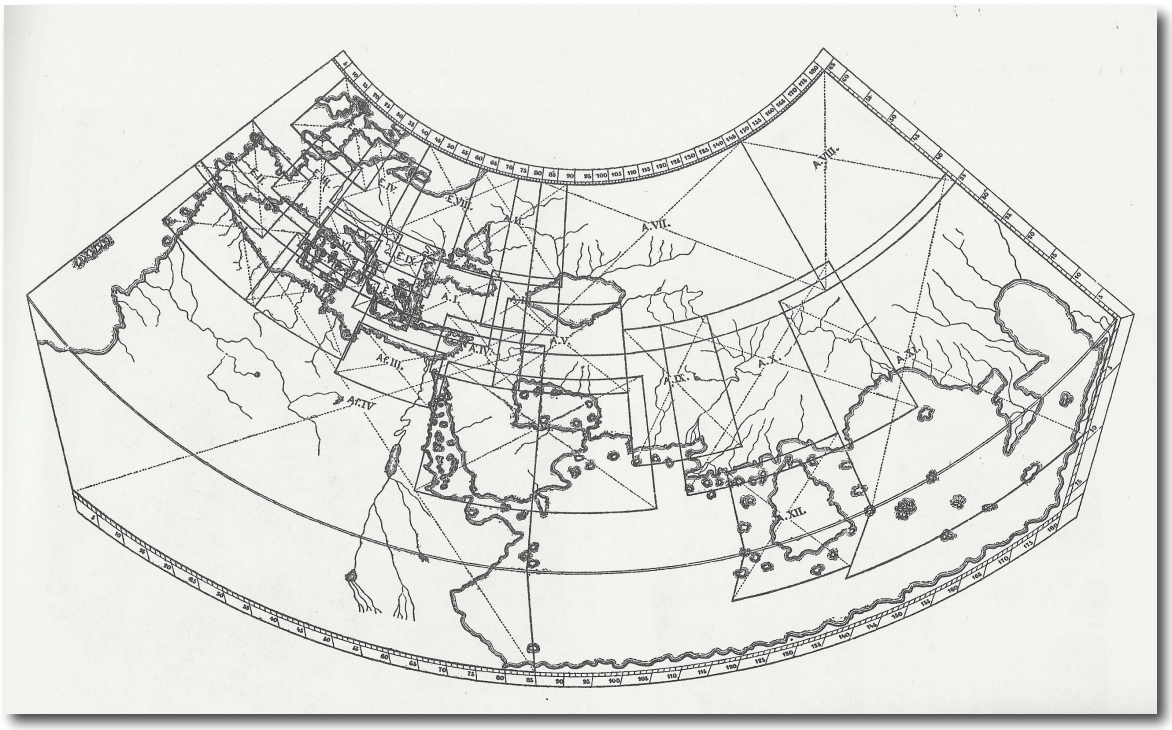
In the eighth and last Book of the *Geographia*, Ptolemy returned to the business of discussing the principles of cartography, mathematical, geographical and astronomical methods of observation, and, in some cases (manuscript or printed copies) there follow short legends for each of the special maps - ten for Europe, four for Africa and twelve for Asia - mentioning the countries laid down on each plate, describing the limits, and enumerating the tribes of each country and its most important towns. It is these legends which, in some editions, have been placed on the reverse of the maps, and they appear to have been originally intended for that purpose. In addition, a description of a projection of the inhabited hemisphere on a plane, by which it could retain its circular outline, or globular aspect is also given. Ptolemy himself never actually employed this manner of projection, which has since, through more or less modified, been preferred by geographers for maps representing one of the hemispheres.

Those scholars who have argued that Ptolemy's original text contained no maps have neglected careful study of this Book. In Chapter Two Ptolemy said, *"It remains for us to show how we set down all places, so that when we divide one map into several maps we may be able to accurately locate all of the well-known places through the employment of easily understood and exact measurements."* On the other hand, some scholars even go so far as to say that maps were already drawn before certain portions of the text was addressed, so that they could be used as models for the completion of other portions of the text.

Ptolemy went on to explain how the more common faults of map makers might be avoided. For instance, in a single map embracing the entire earth, he said, there is a tendency to sacrifice proportion, that is, scale, in order to get everything on the map. The better known regions have many place-names, while the lesser known have few, and, unless the map is carefully drawn, it will have some crowded, illegible areas, and some where distances are unduly extended. Some map makers have a tendency to exaggerate the size of Europe because it is most populous, and to contract the length of Asia because little is known about the eastern part of it. And some cartographers surround the earth on all sides with an ocean that, according to Ptolemy are "making a fallacious description, and an unfinished and foolish picture". The obvious way to avoid crowding, Ptolemy said, is to make separate maps of the most populous regions or sectional maps combining densely populated areas with countries containing few inhabitants, if such a combination is feasible. If several regional maps are made to supplement the general world map, they need not "measure the same distance between the circles", that is, be drawn to the same scale, provided the correct relation between distance and direction is preserved. Ptolemy repeated that it would be not too far from the truth if instead of circles we draw straight lines for meridians and parallels. As for his own policy, he said, "*in the separate maps we shall show the meridians themselves not inclined and curved but at an equal distance one from another, and since the termini of the circles of latitude and of longitude of the habitable earth, when calculated over great distances do not make any remarkable excesses, so neither is there any great difference in any of our maps*". These things being so, he continued, "*let us begin the task of a division such as the following: We will make ten maps for Europe; we will make four maps for Africa; for Asia we will make twelve maps to include the whole, and we will state to which continent each map belongs, and how many and how great are the regions in each...*" The latitude of each place would be given as well as the length of the longest day in equinoctial hours. The longitudes would be

determined from the meridian of Alexandria, either at sunrise or sunset, calculating the difference in equinoctial hours between Alexandria and point two, whatever it might be.

The illustration above gives a diagram of the parts of the known world embraced by each special map found in Ptolemy's *Geographia*. It demonstrates how Ptolemy's world had been systematically divided into twenty-six regions, each of which is mapped on a separate sheet. Generally these sheets are of about the same size, but the scales vary according to the space required for the legends. As this diagram shows, each regional map would encompass, besides its own proper territory, some parts of the neighboring countries. But, as is also usual in modern atlases, these neighboring areas of the map are only roughly sketched, while the principle area is shown in full detail. As mentioned earlier, the original text called for twenty-six regional or special maps, which in all extant manuscript copies bear a strong family resemblance and are laid down on the projection apparently used by Marinus in the form of isosceles trapezoids. Some of the other conspicuously modern conventions include the previously noted lack of ornamentation, his method of differentiating land and water, rivers and towns, by



means of either hachures or different colors, and his use of 'standardized' symbols all of which is accepted at first glance without a thought being given to the origin of the technique. This particular projection shown of the general map of the habitable world, the one believed to be employed by Ptolemy in his original general map, is laid down in the lazy man's projection he talked about, the *modified conic* instead of the *spherical* projection that he recommended for a faithful delineation of the earth's surface.

While there is little doubt still lingering that Ptolemy's text was originally illustrated by maps, it is not altogether certain that the maps found today in existing copies of the *Geographia* are indeed similar to those of the original series of maps, since the latter have not survived for comparison. The reason for this doubt lies in the question of authorship of the maps which accompany extant copies. Did Ptolemy

actually design and construct the maps himself, were they made by a draftsman working under his supervision, or were they added, perhaps as late as 1450, by an energetic editor who thought the text needed some graphic emendation? Ptolemy does not state specifically in his text whether he personally made any maps, and proponents of the theory that Ptolemy made no maps for this *Geographia* base their case on the notation in two of the existing manuscript copies, that a cartographer named Agathodæmon of Alexandria was the author of the accompanying map(s). From these same manuscripts it is stated that "he drew them according to the instructions in the eight books of Claudius Ptolemy". However, this statement has never been dated and, confusingly, Agathodæmon's single-sheet world map employs a projection unlike any proposed by Ptolemy's text. This particular world map is usually found at the end of Book VII, preceded by three chapters containing some practical advice, a general description of all known areas of the world and the three principle seas (the Mediterranean, the Caspian and the Indian Ocean), with their bays and islands, and instructions for drawing a sphere and maps on a plane surface. Many scholars ascribe these three chapters to Agathodæmon, as the descriptive text for his map. However, the authorship of the other twenty-six maps is still in doubt.

To further confound the issue, all of the other manuscript copies of the *Geographia* that are accompanied by maps differ one from another, presenting two basic versions. According to map historian Leo Bagrow, one version, **A**, contains twenty-six large maps included in the eighth Book of the text, each folded in half and, on the back, having a statement of the region portrayed, its bounds and a list of principle towns. The geographical coordinates of these towns are given, not in degrees, but in time; the longitude is expressed in hours and minutes corresponding to the distance from the meridian of Alexandria (one hour = 15 degrees, one minute = 15 minutes of a degree), and the latitude is expressed in terms of the length of the longest day, in hours and minutes (the greater the distance from the equator, the longer the day in summer).

The other version, **B**, contains sixty-four maps distributed throughout the text, vice collected together in one place. In some manuscripts of the B-version, and in those without maps, the texts from the backs of the maps are combined together in a special edition, divided into chapters numbered 3-28. There follows supplementary information on satrapies, provinces, etc. and a table of the latitudes and longitudes of each map.

Over and above these maps, those manuscripts with maps, both A- and B-versions, are additionally illustrated with a universal map of the entire known world at Ptolemy's time, either on one sheet or four sheets; only very rarely are both world maps found together. Of the Greek manuscripts of the *Geographia*, as a whole or in part, known today, eleven of the A-version and five of the B-version have maps. Some of the manuscripts without maps contain references to accompanying maps, since lost, and in others, spaces have been left for maps to be inserted. It is no less difficult, also, to determine when the maps of the two versions (A and B) were made. Certain indications point to the Byzantine period, with the exception of Agathodæmon's single-sheet world map. But, again, when they were constructed - totally and faithfully copied from the originals, or constructed from Ptolemy's instructions but without benefit of original models - is significant in trying to determine the degree of similarity to their 'prototype' and the possibility of additions or corrections based upon more contemporary knowledge. It is noteworthy here to point out that, regardless of when these existing manuscript reproductions were made, they somehow escaped the pictorial fancies such

as sketches of animals, monsters, savages, ships, kings, etc. as adorn the manuscript maps of the Middle Ages and many of the printed maps of the 16th century.

As with modern maps, Ptolemaic maps are oriented so that North would be at the top and East at the right, because better known localities of the world were to be found in the northern latitudes, and on a flat map they would be easier to study if they were in the upper right-had corner. The meridians are spaced from each other "*the third part of an equinoctial hour, that is, through five of the divisions marked on the equator*". In other words, the total span of twelve hours, representing the length of the habitable world, was to be partitioned by a series of thirty-six meridians spaced five degrees apart at the equator and converging at the North Pole. The meridians in the southern hemisphere are extended from the equator at the same angle as those above it, but instead of converging at the South Pole they terminated at the parallel 8° 25′ below the equator.

Displayed on the left-had margin of these world maps are seven *Clima [Klima]* and *Parallel Zones*. In Ptolemy's time, the latitude, or distance from the equator, was generally astronomically calculated from the length of the longest and the shortest day. The earth was accordingly divided into a number of zones, parallel to the equator and within which these days had a certain length, for instance of 12 -13, or 15 -16 hours. The concept of the division of the earth into zones began as early as the sixth century B.C. with a Greek scholar named Permenides of Elea and were called *climates* from the Greek word meaning *inclination*. Different from what is now accepted as the meaning, this word in ancient maps had a purely geographical, not a meteorological significance, although they also perceived that the climate of a region was somewhat related to its distance from the equator. The lines that separate the *Climata* were termed *Parallels*. As can be seen from these world maps, Ptolemy divided the northern hemisphere into twenty-one parallels, noted, again, in the margin of this maps. The parallel bounding the southern limit of the habitable world is equidistant from the equator in a southerly direction as the parallel through *Meroe* is distant in a northerly direction. Ptolemy laid down his parallels from the equator to *Thule*. The twenty-one parallels are spaced at equal lineal intervals and each one is designated by (1) the number of equinoctial hours and fractional hours of daylight on the longest day of the year and (2) the number of degrees and minutes of arc north of the equator. For example, the first parallel of latitude north of the equator was distant from it "the fourth part of an hour" and "distant from it geometrically about 4°15′". One other parallel is added south of the equator, identified with the *Rhaptum* promontory and *Cattigara* and about 8° 25′ distant from "The Line". All of the parallels north of the equator are located theoretically with the exception of three: *Meroe, Syene* and *Rhodes*. The first one, *Clima I per Meroe*, (so called because it passes through *Meroe*, near modern Shendi, a city of Africa at 17° N latitude) was established traditionally as 1,000 miles below Alexandria and 300 miles from the torrid zone; it was also known as the royal seat and principal metropolis of *Ethiopia* [Africa].

Clima II per Syene passes through *Syene*, the modern Aswan, which was still considered as one of the very few scientifically located parallels because of the fact that it lay on the line of the Summer Tropic and was always included in any discussion of the parallels; *Clima IV per Rodo* passes through *Rhodes*, which had become the most popular parallel of all and was located by common consent at 36° N.; *Clima VI per Rondo* passes through *Pontus* [the Black Sea], and so on. The numbers on the right of the *Clima* give the number of hours in the longest day at different latitudes, increasing from 12 hours at the equator to 24 hours at the Arctic Circle.

A 15th century manuscript copy of the Greek text of Ptolemy's Geopgraphy
British Library, Additional MS 19391, ff. 17v-18

Overall Ptolemy's world-picture extended northward from the equator a distance of 31,500 *stades* [one *mile* = 9 to 10 *stades;* there has always been some controversy over the equivalent modern length of a *stade*] to 63° N at *Thule*, and southward to a part of *Ethiopia* named *Agysimba* and *Cape Prasum* at 16° S latitude, or the same distance south as *Meroe* was north. The "breadth" of the habitable world according to Ptolemy then equates to 39,500 *stades* [3,950 miles]. It is remarkable that, while his map is consistently mentioned as reflecting the entire inhabited portion of the globe, there is no indication on any of his world maps of habitation south of *Agysimba*, though there is some hint of his belief/knowledge to the contrary in his criticism of Marinus on this point.

Marinus estimated that the length of the known habitable world, i.e. the distance between the *Fortunate Islands* [Canary-Madiera Island group] in the west, and *Cattigara* [Borneo?] in the east, to be a distance of 15 hours of longitude, 230° (11,250 miles) at the equator. Ptolemy "corrected" this length to 180° (9,000 miles), still 50° (2,500 miles) too long, an error arising from using the *Fortunate Islands* as his prime meridian which he placed about seven degrees (350 miles) too far to the east. Contributing to this mistake was Ptolemy's (and Marinus') rejection of the surprisingly accurate calculation of the circumference of the earth, made by Eratosthenes (276 -196 B.C.) of 252,000 *stadia* [25-28,000 miles]. Instead Ptolemy/Marinus adopted the figure derived by Posidonius (135 - 50 B.C.) of 180,000 *stadia* [~18,000 miles] and applied it to the distance measurements available to him, concluding that Europe and Asia extended over one-half of he globe; in reality they cover only 130°. Similarly he showed the length of the Mediterranean as 62°, whereas, in reality it is only 42°. The eastward extension of Asia is also exaggerated,

measuring about 110° from the coast of Syria to the outermost limits of China, instead of the true distance of about 85°.

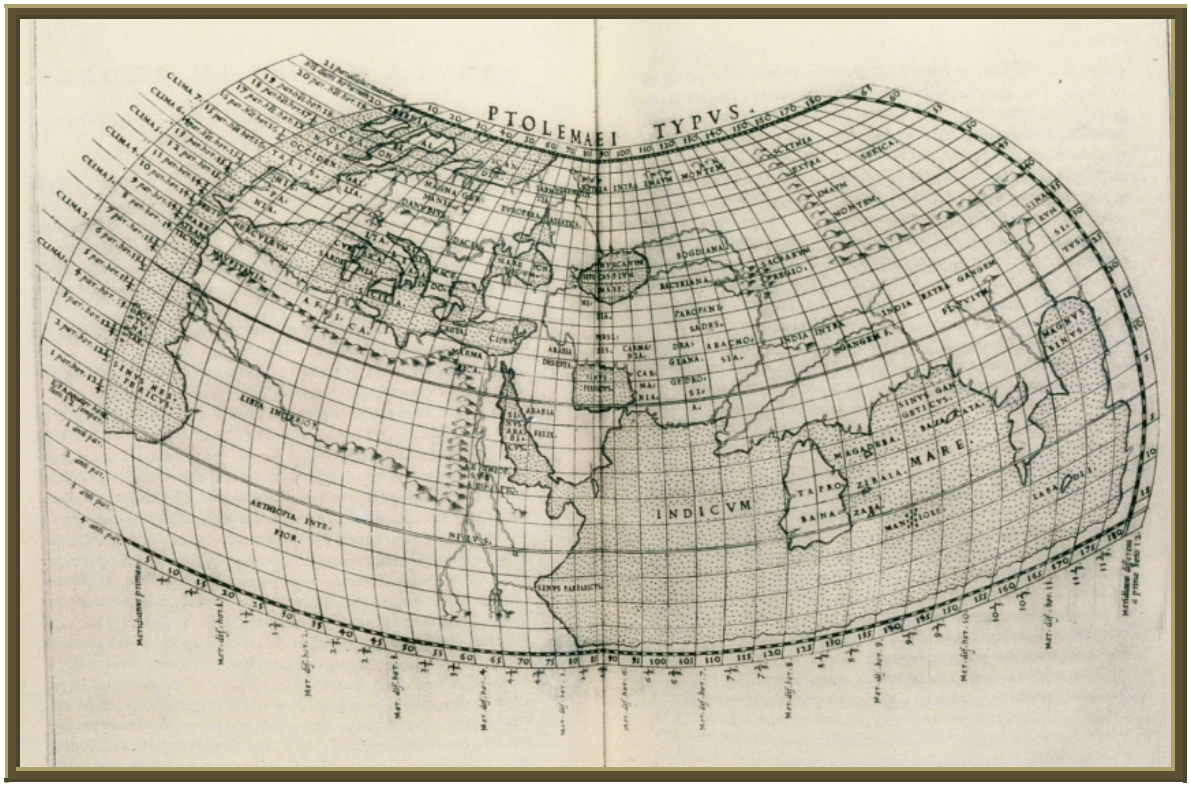
An important observation was made in Paul Schnabel's article of 1930, in which he made the first attempt to distinguish successive stages in the evolution of Ptolemy's geographical ideas, showing, among other things, that the *Almagest*, Ptolemy's main work in astronomy, represents an earlier stage than the *Geography*. In the *Almagest*, Ptolemy held the circumference of the earth to be 252,000 *stades*, a value almost universally accepted in antiquity after it had been proposed by Eratosthenes in the third century BC. In the *Geography*, one of his later works, Ptolemy accepted another value, 180,000 *stades*, which had been little-known before him and would have a profound effect on latter geographers, cartographers and explorers. Before Ptolemy this value was used only twice, by Marinus of Tyre, Ptolemy's immediate predecessor in geography, and by the Stoic philosopher Posidonius (c.135–51 BC). Of equal significance are the undeservedly forgotten works by Antonin Wurm who found that within Ptolemy's map as described in the *Geography* is a remnant of an earlier version based on Eratosthenes' value for the earth's circumference, not Ptolemy's.

A 15th century Ptolemaic world map accredited to Francesco di Antonio del Chierico, based on Jacobus Angelus's 1406 Latin translation of Maximus Planudes's late-13th century rediscovered Greek manuscripts of Ptolemy's Geography. Ptolemy's (modified conic) projection. The British Library Harley MS 7182, ff 58v-59

It has been repeatedly pointed out that the distances set down by Ptolemy in his tables for the Mediterranean countries, the virtual center of the habitable world, are erroneous beyond reason, considering the fact that Roman *Itineraries* were accessible. But were they really available to non-military men such as Marinus and Ptolemy? It is very unlikely, in view of the secrecy attached to all maps and surveys of the Roman Empire. If, as seems

to be the case, Marinus depended for maritime distances largely from the writings of Timosthenes of Rhodes (the admiral of Ptolemy Philadelphus, who flourished about 260 B.C.), there must have been very little information available to a scientist and scholar such as Claudius Ptolemy, who seems to have had no political or military motive, but only seemed interested in the advancement of learning as justification for his investigations. And it is highly probable that Ptolemy the astronomer, who is usually discredited by later geographers because of his methods and the kinds of information he compiled, had no more standing among some of his influential contemporaries than he would today in the most approved geographical circles of the civilized world.

The geographical errors made by Ptolemy in his text and maps constitute the principle topic of many scholarly dissertations. Yet most of his errors arose from nothing more than a dearth of information. He lacked enough reliable facts. The whole world lacked the fundamental data necessary to compile an accurate map. The only good reason for discussing a few of the glaring faults of the *Geographia* is that it was the canonical work on the subject for more than 1,400 years. Geographers of the 15th and 16th centuries relied on it so heavily, while ignoring the new discoveries of maritime explorers, that it actually exerted a powerful retarding influence on the progress of cartography. The *Geographia* was both a keystone and a millstone, a pioneering effort that outlived its usefulness. His hypothetical map was excellent but his world of reality was faulty.



Map on grid system, in Ptolemy, La geographia, 1561-64, 26 x 14 cm,
Oxford University Byw. H 5.9

Paradoxically, Ptolemy's eastward extension of Asia, reducing the length of the unknown part of the world, coupled with his estimate of the circumference of the earth,

was his greatest contribution to history if not cartography. The earth was only 18,000 miles around at the equator; Poseidonius had stated it, Strabo substantiated it, and Ptolemy perpetuated it on his maps. This "shorter distance" that a mariner would have to travel west from the shores of Spain in order to reach the rich trading centers of Asia may have contributed to Columbus' belief, or that of his royal sponsors, that they could compete with their rival neighbors, Portugal, in the newly opened sea-trade with India by sailing west. While Ptolemy's map is based upon the theory that the earth is round, it bares repeating that it is to his credit that he depicts only that half of its surface which was then known, with very little attempt to speculate on or "fill-in" the unknown parts with his imagination.

Ptolemy provides a descriptive summary in his text in which he tells us that the habitable part of the earth is bounded on the south by the unknown land which encloses the Indian Sea and that it encompasses Ethiopia south of Libya, called *Agisymba*. On the west it is bounded by the unknown land encircling the *Ethiopian Gulf of Libya* and by the *Western* [Atlantic] *Ocean* which borders on the westernmost parts of Africa and Europe; on the north, *"by the continuous ocean called Ducalydonian and Sarmantian which encompasses the British islands, the northernmost parts of Europe and by the unknown land bordering on the northernmost parts of Greater Asia; that is to say, on Sarmatia, Scythia and Serica"*.

There are three seas surrounded by land. Of these, the *Indicum Mare* [Indian Ocean] is the largest, *Our Sea* [the Mediterranean] is the next and the *Hyrcanian* [Caspian] is the smallest. Among the most noted islands of the world are *Taprobane* [Ceylon/Sri Lanka and, perhaps, Sumatra], the island of *Albion* [Britain], the *Golden Chersonesus* [the Crimea], *Hibernia* [Ireland], *Peloponnesus* [Morea]; then come Sicily, Sardinia, Corsica (also called *Cyrnos*), Crete and Cyprus. More specifically, Ptolemy's knowledge concerning the fringes of the habitable world and civilization was broader than earlier writers, such as Strabo *(#115)*, but in some respects it was a little confused. In the northern regions, for example, he had been ill-advised with regard to Ireland, and positioned it further north than any part of Wales; likewise, Scotland was twisted around so that its length ran nearly east and west. The Scandinavian peninsula was shown as two islands, *Scandia* and *Thule*. The northern coast of Germany beyond Denmark, *Cimbrica Chersonese*, is shown as the margin of the *Northern Ocean*, and running in a general east-west direction. The northern coast of Asia is not shown at all.

The southern limit of the habitable world had been fixed by Eratosthenes *(#112)* and Strabo *(#115)* at the parallel through the eastern extremity of Africa, Cape Guardafiri, the cinnamon-producing country and the country of the *Sembritæ* [Senaai]. This parallel also passed through *Taprobane* usually considered the southernmost part of Asia. The extent of Africa below this parallel is left an unanswered mystery.

Ptolemy records, following Marinus, the penetration of Roman expeditions to the land of the *Ethiopians* and to *Agisymba*, a region of the Sudan beyond the Sahara desert, perhaps the basin of Lake Chad, and he supplied other new information regarding the interior of North Africa. As to the source of the Nile, both Greeks and Romans had tried to locate it, but without success. The Emperor Nero had sent an expedition into Upper Egypt, and it had penetrated as far as the White Nile, about 9° N latitude. But the source had not been reached. Ptolemy introduces the term *Mountains of the Moon* and states that the Nile arose from two streams in these mountains, the outlets of two lakes a little south of the equator, which was closer to the truth than any previous conception until the discovery of the Victoria and Albert Nyanza in modern times.

The eastern coast of Africa was better known than the western, having been visited by Greek and Roman traders as far as *Rhapta* [Rhaptum Promontory opposite Zanzibar?] which Ptolemy placed at about 7° S. To this he added a bay extending to *Cape Prasum* [Delgado?] at 15.5° S. On the same approximate parallel he located the region called *Agisymba*, inhabited by *Ethiopians* and abounding in *rhinoceri*, supposedly discovered by Julius Maternus, a Roman general. With *Thule* as the northern limit of Ptolemy's habitable world, he thus extended the breadth of this world from less than 60° (Eratosthenes and Strabo) to nearly 80°.

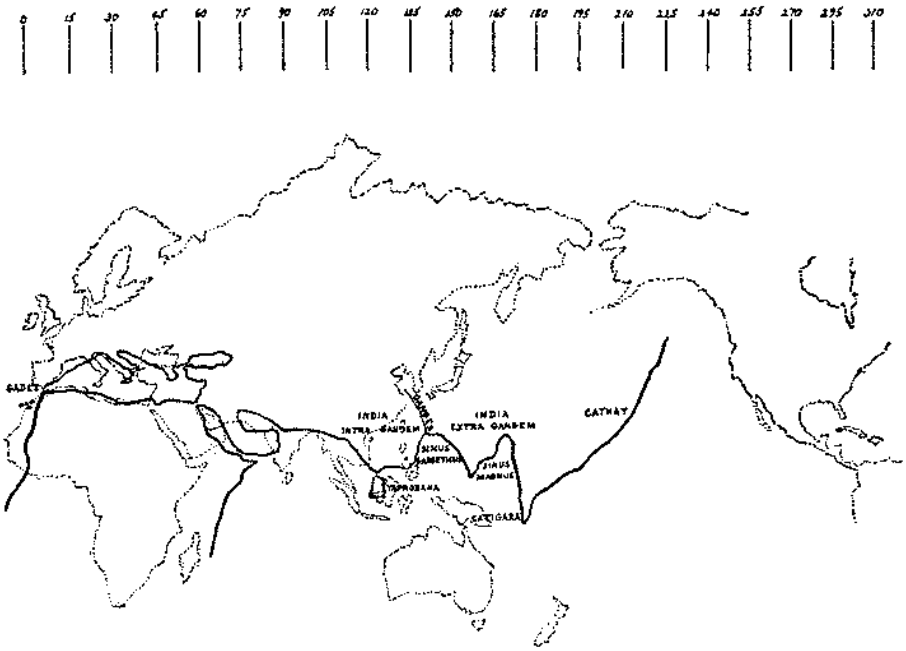
According to Greek tradition, an extension of 20° in the width of the habitable world called for a proportionate increase in its length. Ptolemy extended the west coast of Africa with a free hand, and even though he reduced the bulge made by Marinus more than half, it was still way out of control. A more obvious area to stretch the length of the world was in eastern Asia where there was every likelihood of additional territory yet unexplored. The silk trade with China had produced rumors of vast regions east of the Pamir and Tian Shan, hitherto the Greek limits of Asia. Ptolemy took very little stock in the seven-month's journey to *Sera* [China] and refused to follow Marinus who said the distance was 3,620 miles from the *Stone Tower* to *Sera*, but instead cut the distance in half without presenting any critical evidence/argument.

Ptolemy's knowledge of the vast region from *Sarmatia* to China was, however, better than that of previous map makers. He shows, for the first time, a fairly clear idea of the great north-south dividing range of mountains of Central Asia, which he called *Imaus*, but he placed it nearly 40° too far east and made it divide *Scythia* into two parts: *Scythia Intra Imaum* and *Scythia Extra Imaum Montem* [Within Imaus and Beyond Imaus]. Asia and Africa are extended considerably to the east and south, far more so than on any previous maps, but not without cause. These distortions represented an actual extension of geographical knowledge and are doubtless based on exaggerated reports of distances traveled. All such information was of doubtful origin, and in laying down the coastline of Eastern Asia, Ptolemy ran the line roughly north and south. Instead of continuing it to the *Land of the Linæ* [seacoast of China] he curved it around to the east and south, forming a great bay, *Sinus Magnus* [roughly the Gulf of Siam]. Continuing it around to the south until it joined *Terra Incognita* at the southern limit of the habitable world, he made a lake of the *Indicum Mare* [Indian Ocean]. To judge, therefore, from the map, Ptolemy discarded both the older Greek belief that the earth was surrounded by water, and Herodotus' description of the Phoenician's circumnavigation of Africa. Yet this Ptolemaic theory was later mysteriously "re-interpreted" by Martin Waldseemüller in 1507 *(see monograph #310)* and again by Gerard Mercator in 1569 as a belief by Ptolemy in an all encircling great ocean. That paradox notwithstanding, though, Ptolemy's depiction of a southern Afro-Asian continent and a land-locked Indian Ocean provided little comfort during the intervening 1,300 years to those early explorers, and later the Portuguese, in their attempts to find an all water route to India.

Many faults appear in Ptolemy's picture of southern Asia, although for more than a century commercial relations between western India and Alexandria had been

flourishing. An important document entitled *The Periplus of the Erythræan* [Indian] *Sea* (ca. A.D. 80) containing sailing directions from the Red Sea to the Indus and Malabar, indicated that the coast from *Barygaza* [Baroch] had a general southerly trend down to and far beyond *Cape Korami* [Comorin], and suggested a peninsula in southern India. Ptolemy, apparently following Marinus, ignored this document, or else never saw it because the shape of his India is unduly broadened and foreshortened. Eratosthenes, via Strabo, reported that the southern capes of India lay opposite to *Meroe*. For the most part, the lands beyond the Ganges were not well known until a thousand years later when the brothers Polo first acquainted western Europe with the existence of a number of large islands in that part of the world. And there were no good maps of the East Indian Archipelago until after the Portuguese voyages to the Indies. The legendary island of *Taprobane* [Sri Lanka, and possibly Sumatra], whose size had always been grossly over-estimated, was not improved by Ptolemy, who extended it through 15° of longitude and 12° of latitude, making it about fourteen times as large as it really was and extending its southerly tip more than 2° below the equator.

Even the more familiar territory of the Mediterranean basin demonstrated that insufficient contemporary knowledge was available and Ptolemy erred in many important cartographical details. His Mediterranean is about 20° too long, and even after correcting his lineal value of a degree it was still about 500 geographical miles too long. His *Mare Nostrum*, from Marseilles to the opposite point on the coast of Africa, is 11° of latitude instead of the actual 6.5°. The best known parallel of latitude (36° N) was not a parallel at all as Ptolemy drew it. Leaving the habitable world from the Strait at the *Pillars of Hercules* to the *Gulf of Issus*, it passed through Caralis in Sardinia and *Lilybaeum* in Sicily (30° 12′ and 37° 50′ N). *Carthage* is positioned 1° 20′ south of the parallel of Rhodes; actually it is one degree north of it. *Byzantium* is placed in the same latitude as *Massilia*, which made it more than two degrees north of its true position. This particular error threw the whole *Euxine Pontus* [Black Sea], whose general form and dimensions were fairly well known, too far north by the same amount, over 100 miles. His exaggeration of the *Palus Mæotis* [Sea of Azov] plus the fact that he switched its direction to north-south, brought its northern extremity, the *Tanais* [Don] estuary, as high as 54° 30′, the true latitude of the south shore of the Baltic Sea!



Ptolemy's view of the world superimposed over a Mercator projection of the known world of today

However, Ptolemy was apparently the first of the ancient geographers to have a fair conception of the relations between the *Tanais*, usually considered the northern boundary between Europe and Asia, and the *Rha* [Volga], which he said flowed into the Caspian Sea. Ptolemy was also the first geographer, excepting Alexander the Great, to return to the correct view advanced by Herodotus and Aristotle, that the Caspian was an inland sea without communication with the ocean (the European Christian medieval cartographers were a long time in returning to this representation of the Caspian).

Not surprisingly, it is impossible to identify many of the places - cities, lakes, rivers, mountains named by Ptolemy, and this serves to underline what the author himself explained, that his geography is collated and harmonized from many earlier sources, many of them of doubtful precision, and many quite unverifiable. Ptolemy's aims and methods were rigorous and scientific, but his materials were not equal to his demands on them. To establish longitude, for example, from a travel narrative where distances were given in days' journeys, was quite impossible. Nevertheless the extent of Ptolemy's world is impressive, extending far beyond the Graeco-Roman heartland, into India, China and South-East Asia. Ptolemy plainly did not believe in the circumnavigation of Africa, although he was surely aware of the legend: his depiction of the Indian Ocean as an enclosed sea was pure theory. China is known as the source of the silk trade (its Latin name *Serica Regio* meant simply "silken kingdom"), but Ptolemy knows no sea east of the Malay peninsula: on the eastern ocean that bounds Eurasia, he does not care to speculate. With all their imperfections Ptolemy's maps of Asia are remarkable testimony to the trade routes that linked east and west, for we have no contemporary narrative accounts of them. They were not under Greek or Roman control, and this geographical data must have come through many traders, mariners and adventurers of whom we know nothing. Ptolemy's world map represents a geographic vision unmatched by any earlier civilization; and one that would not be superseded for fourteen centuries.

In spite of the egregious errors on all of Ptolemy's maps, its wealth of detail still constitutes one of the most important sources of information for the historian and student of ancient geography. This is especially true in the study of the earliest tribes that encompassed the Roman Empire in the first century of the Christian era, who were at that time barbarians, but who later bore the burden of civilization in Europe. To be sure, there are other geographical fragments, individual maps and charts, isolated examples of the best in Greek, Roman, and Arabic cartography, but Ptolemy's *Geographia* is the only extant geographical atlas which has come down to us from the ancients. There is nothing in the literature to indicate that any other such systematic collection of maps was ever compiled, with the exception of the maps of Marinus, about which almost nothing is known, save what Ptolemy has mentioned.

The form of his atlas and the maps themselves are the prototypes of modern mapmaking. Many of the legends and conventional signs that he used are still employed by cartographers with only slight modifications. He originated the practice of orienting maps so that North is at the top and East to the right, a custom so universal today that many people are lost when they try to read a map oriented any other way. His map projections, the *conical* and *modified spherical*, as well as the *orthographic* and *stereographic* systems developed in the *Almagest*, are still in use. The listing of place-names, either in geographical or alphabetical order, with the latitude and longitude of each place to guide the search, is not so different from the modern system of letters and numerals employed to help the reader, a little convenience that is standard on modern maps and Ptolemaic in origin.

During the intellectual narrow-mindedness of the Middle Ages even Ptolemy and his methods of map construction were forgotten, at least in the west. Ptolemy's works were, however, thriving and contributing valuable insight to knowledgeable Arabs and those having access and understanding of the Arab or Greek language (it was only in the Islamic states and in these languages that the works of the Alexandrian scientist were preserved *(see monographs #212, #213, #214-17*, lbn Said, al-lstakhri, Ibn Hauqal, al-Kashgari, etc.).

The process by which Claudius Ptolemy became the Arabs' *Batlamiyus Kludiya*, and entered a completely alien linguistic and cultural universe, is of absorbing interest. In early ninth-century Baghdad, a conscious effort was made under the Caliph al-Ma'mun to produce Arabic versions of Greek scientific and philosophical works. The toleration that Islam extended to peoples with a shared scripture tradition – "The Peoples of the Book" - meant that Muslim scholars who did not know Greek were able to benefit from direct contact with Christian scholars who did. Nestorian Christians who had maintained the traditions of the Alexandrian academy were attracted to the brilliant court in Baghdad. Here they were safe from Byzantine persecution, and were able to meet Muslim and Jewish scholars avid for Greek learning. Some Arab scholars were able to master Greek and work directly with the original texts, or translate them into Arabic. Other scholars worked through the intermediary of translations from Greek into Syriac, prepared by Nestorian Christians.

There is hardly a work of Greek science or philosophy that was not available in Arabic by the mid-ninth century. Al-Hajjaj finished his translation of the *Almagest* in 826; the *Geography* may have been translated even earlier. These two books established the framework within which astronomical and geographical researches were to be conducted for the next 700 years.

Ptolemy was not received passively in the Islamic world. From the very beginning, the *Almagest* and the *Geography* were subjected to very critical scrutiny. The observatories set up by al-Ma'mun were used to correct Ptolemy's star catalogue; the Geography was recast, coordinates re-calculated and hundreds of new observations added. His mathematics were some times violently criticized, amended and refined as new instruments were invented and more sophisticated mathematical tools became available. As more early Arabic texts are edited and published, the originality of the work of Muslim scientists and mathematicians becomes increasingly apparent.

The Arabic versions of Greek texts prepared in ninth-century Baghdad circulated throughout the Islamic world. The translations were revised, commentaries were written upon them, and original works were composed that used the naturalized texts as points of departure.

This growing body of scientific literature, for the most part produced in little more than 100 years, found its way to western Islamic lands very early. Cordoba became a leading intellectual center in *al-Andalus*, or Muslim Spain, in the 10th and 11th centuries. When Toledo fell to the Christians in 1085, an-other effort was made to transfer the legacy of the ancient Greeks to another language, this time to Latin. In the early 12th century, Muslim, Christian and Jewish scholars produced a corpus of translations, from the Arabic, of the Greek authors and their Arabic commentators.

In Christian Western Europe, instead of Ptolemaic-like maps that are clear, intelligible, drawn in proper proportion and referenced by astronomical observations, maps were constructed without as sense of proportion (e.g., medieval T-O maps), covered with figures of princes in mantle and crown, blank spaces filled with monsters and fantastic legends and often were produced merely as thematic illustrations/ornamentation for some religious text or local church. There were some rare exceptions that broke with this tradition and portrayed a more "scientific", though still non-Ptolemaic, outlines of the known world - i.e., the *Cottonian Map*, the *Catalan Atlas*, *Fra Mauro's Map* and, of course the nautical or *portolan* charts.

The presently known version of Ptolemy's works began to surface in western Europe when the Byzantine monk Maximos Planudes (1260 - 1310) succeeded in finding and purchasing a manuscript copy of the *Geographia*. This copy, which is now in the Vatican Library (Vat.Gr.177), contained no maps, but only Agathodæmon's remarks on the construction of his world map. Planudes constructed a map based upon the instructions found in Ptolemy's eight books and subsequently, through Athanasios, Patriarch of Alexandria, had a copy of the *Geographia*, with maps made for Emperor Andronicus III. This particular copy has not been recovered, however another copy attributed to Planudes is preserved, in part, in the monastery of Vatopedi on Mount Athos.

Another scholar of the Byzantine age is known to have been interested in Ptolemy's *Geographia* - the noted polyhistor Nikephoras Gregoras (1295 - c. 1359), who added various notes or comments, generally in the margins to the text or maps. He is also credited with the four-page world map found in some manuscripts, chiefly the B-version. It was also during this time, the 14th century, that the twenty-six maps of the A-version were divided up into sixty-four. Thus there was an "evolution" of the *Geographia*, originating with the creation of Ptolemy and gradually developed in various forms by three or four different hands/minds over the course of twelve centuries, reaching the 14th/15th century in a doubtful state of the original, especially the maps.

In 1400 a Greek manuscript copy of the A-version (twenty-six maps) was obtained from Constantinople by the Florentine patron of letters, Palla Strozzi, who persuaded Emmanual Chrysoloras, a Byzantine scholar, to translate the text into Latin. Very few scholars, let alone other literate persons in Western Europe were familiar with the Greek language at this time, therefore this translation was a great stimulus to "popularizing" Ptolemy. When Chrysoloras was unable to complete the translation, it was finished by one of his students, Jacobus Angelus of Scarparia, between 1406 and 1410. This oldest Latin translation of Ptolemy's *Geographia* (confusingly and arbitrarily titled *Cosmographia* by Angelus) was at first disseminated in numerous, often splendidly decorated manuscript copies. This was a time of the rekindling of worldly interest and curiosity. Corrected and amended by a succession of editors, this version also formed the basis upon which all of the editions of the 15th century are built.

Again, the original manuscript of Angelus' translation and the first maps of Ptolemy in the Latin language have not survived, but a manuscript copy, dated 1427, prepared under the direction of Cardinal Fillastre, can be found in the library at Nancy, France (thus known as the *Nancy Codex*).

In manuscript form, four other cartographers are significant in editing and influencing the evolution of Ptolemy's atlas. These include P. del Massajo (1448 -1472), a Florentine cartographer who is credited with introducing the practice of adding 'modern' or contemporary maps to the Ptolemaic map selection of twenty-six; Nicholaus Gemmanus [Nicolas Donis], 1464 - 1471 who claimed four "improvements" for his versions: smaller, more convenient size maps; employment of a new projection - the trapezoidal; the correction of the outlines of various countries; and the addition of new maps (his manuscript maps were the basis for the Bologna edition of 1477 and the Rome edition of 1478); and Francesco Berlinghieri and Henricus Martellus, both about 1480.

After the discovery of copper-plate and wood-engraving, Ptolemy's atlas became one of the first great works for the reproduction of which these arts were employed. Curiously enough it was first printed at Vincenza in 1475 (the date printed of 1462 is in error) *without maps*! In all, seven editions were printed in the 15th century, of which six were provided with large maps in folio, and thirty-three in the following century *(a selected list taken from Tooley accompanies this monograph).* The demand for knowledge of the progress of modern geographical discovery, plus the immortal reputation acquired by the name Ptolemy, became so great that during the next 250 years the *Geographia*, in its constantly improved/expanded form, still continued to be the standard work on the subject, so much so that upwards of 50 editions or collateral works appeared before 1730. Today it survives in 65 Greek manuscripts. Of those 16 comprise the text of the treatise and the maps, and 49 only the text, or part of it with or without *scholia.*

With respect to whether or not Ptolemy actually produced any maps, or who might have made maps based upon Ptolemy's instructions, Dr. Stella A. Chrysochoou has written a compelling article that addresses this issue. The following are some excerpts from that article.

The question: who constructed the existing maps, Ptolemy or the Late Byzantium has been asked from the end of the 19th century to the present day. There are two views: the one supported by the German speaking philologists, which attributes everything to Ptolemy, and which – without any study of the Byzantine sources – believes that the Byzantine scholars were simply copyists. The second view is from Socrates Kugeas and is followed by a group of scholars, who focused on the maps. They concluded that the treatise is a large cartographical database with detailed instructions enabling anyone to

construct a map. Ultimately that was Ptolemy's goal: to provide instructions, because he was aware that the continuous copying of the same map distorts its outlines. He clearly says that in Book I:

> "We must still investigate the method of drawing a map. This undertaking can take two forms: the first sets out the *oikoumene* in a part of a spherical surface, and the second on a plane. The object in both is the same, namely convenience; that is, to show how, without having a model already at hand, but merely by having the sections in the treatise beside us, we can most conveniently make the map. After all, continually transferring [a map] from earlier exemplars to subsequent ones tends to bring about grave distortions in the transcriptions through gradual changes"

The treatise then, comprises instructions, guides, as its title shows. A most detailed examination of the sources from the second to 12th century AD testify to the knowledge of the treatise by later scholars, who spoke with great admiration and respect for its author (Pappus of Alexandria, Ammianus Marcellinus, Theon of Alexandria, Synesius of Cyrene, Cassiodorus, Stephanus Byzantius).

Working in Alexandria, a major center of commerce, scholarship and culture, Ptolemy collected geographical and astronomical data from any available source — including lists of locations used in itineraries over land and accounts of coastal voyages. He was a 'polymath' on account of his profound knowledge of all branches of the exact sciences, including mathematics, astronomy, physics, optics, harmonics and geography. Ptolemy's approach to geography is his strict scientific method, devoid of any desire to propagate or please political interests and masters. In his geographical texts he never mentions anything about the powerful Roman Empire of his time.

The same, seems to me, to be true for the "humanist" Planoudes, on account of his own contributions not only to mathematics, astronomy, harmonics and geography, but also to grammar and rhetoric, translations of Latin works, editions and commentaries of texts, poetry and theology. Presumably, the most outstanding of all his scientific achievements was the revival of the Ptolemaic *Geographike Hyphegesis*, and the construction of the maps.

Planoudes' legacy was followed by Gregoras, Argyros, Chortasmenos. All of them were monks or clergymen, who apart from theology studied also classical texts and scientific treatises, especially mathematics. This shows the degree of freedom scholar-churchmen enjoyed in Orthodox Byzantium in their pursuit of secular wisdom. They had studied the Ptolemaic *Geography*, not as topographers engineers in the service of the empire. It is hard to believe that the Emperor Andronikos II could ever decide to send these pious monks to survey the boundaries of the state! This in turn raises the question whether these scholars, while constructing their maps, had in their minds cartography in its proper sense, that of a science aiming to represent with accuracy the space of the earthly sphere on a plane surface, or whether they were simply enjoying an academic exercise of a very high standard, as philosophers do in the sphere of ideas.

Following Ptolemy's approach, Planoudes and the other Byzantine scholars who studied the *Geographike Hyphegesis* did not attempt to correct or update Ptolemy's treatise on the basis of contemporary geographical information available to them. Nor is there evidence to suggest that they traveled or navigated in order to confirm Ptolemy's data, or indeed that they questioned these data —they simply accepted that these were accurate and indisputable.

This academic exercise, or 'intellectual game' one might say, of constructing the map of *oikoumene* and regional maps solely on the basis of the data provided in Ptolemy's *Geographike Hyphegesis*, involved no less an emperor, a patriarch and a team of scholars, scribes and craftsmen, some of whom were men of the cloth, who continued the long tradition of the study of ancient Greek literature and culture in Byzantium. In the Greek Orthodox East, ancient Greek texts were always available and therefore they were read, studied, re-edited and commented upon continually throughout the Byzantine period and beyond. Thus, in the last two centuries of the Eastern Roman Empire —the so-called Byzantium— the rebirth of Ptolemy's *Geographike Hyphegesis* held a very important place in the cultural movement, which Steven Runciman describe as "the last Byzantine Renaissance".

It is generally believed that the first maps of the work we have today had been drawn by Planoudes himself around 1297. The important thing is that, although the scholars agree that Ptolemy had for sure drawn maps in his career, the *Geography* - at least in its known form - had never been illustrated before Plancudes. Therefore, we must keep in mind that the text and illustrations should be considered as different issues and studied separately - not as a whole.

Much has been said about the authorship of the *Geography's* maps and the role of Planoudes. In general it is believed that Planoudes is the creator of the 26 maps accompanying the Ptolemaic text, which, until then included, according to various scholars, one world map attributed to Agathodaimon, an engineer from Alexandria.
and the makers of the *portolan* charts.

The oldest world map ascribed to Ptolemy dates back to the year 1297. This manuscript map was produced and drawn by a team under the Byzantine monk Maximus Planoudes (1260-1330) who worked in Constantinople at that time. The core question is now: what happened during around 1,150 years after Ptolemy? Was there a stand-still in the history of geography and cartography? In the article "Fuat Sezgin and the Re-writing of the History of Geography" by Detlev Quintern, he concludes that this appears highly improbable. Against this backdrop the history of cartography is confronted with several problems. Fuat Sezgin discovered many non-Ptolemaic elements in several of the surviving maps, among them the drawing of a second more southern latitude below the Equator. This is only one among many details analyzed by Fuat Sezgin and which make it seem plausible that the Maʾmun geographers and their followers had an important impact on the so-called Ptolemaic maps which circulated from early 14th century onwards in more than twenty manuscripts before book printing started.

Often histories of cartography qualify the Ptolemaic maps as scientific break-through towards modern world maps, compared to the mainly mythological *mappaemundi* in European medieval times which were more an eschatological guide than maps of the world (e.g. the *Hereford* and the *Ebstorf mappae mundi* dating both back to around 1300 #*224* and #*226*).

Fuat Sezgin developed a convincing and comprehensive answer after more than thirty years of extensive and intensive research in the *Geschichte des Arabischen Schrifttums* (Vol. 10, 11, 12, 13).

Ptolemaic world map A Byzantine Greek world map according to Ptolemy's first (conic) projection. From Codex Vaticanus Urbinas Graecus 82, Constantinople c. 1300. Parchment 575 x 418 mm. Probably assembled by Maximus Planoudes

On the world map of Planudes, ascribed to Ptolemy, the Indian Ocean is depicted as an inland lake, surrounded by a landmass, corresponding to an old belief that was already questioned by Alexander the Great when he reached the Indian coast.

It is an open question why the Ptolemaic World Maps reproduced this obsolete and outdated cartographic depiction that was long before corrected by Arabic cartography. We still find the outdated over-extension of the length of the Mediterranean (63 degrees) and the "melon-shape" of the Caspian Sea.

Few authors in the history of Western cartography and geographical thought have had the same resonance and impact as Ptolemy. Since the "rediscovery" and Latin translation of his Geography (1409/10), the Alexandrian astronomer and geographer seems to have retained a sort of mythical status throughout the centuries. We find him in 15th century miniatures, dressed in lavish regal garments (the result of a confusion by medieval Europeans who mistook him for a member of Egypt's Ptolemaic dynasty), or on the walls of Florentine *studioli* portrayed as a long-bearded Byzantine wise man. We find him on the top of Martin Waldseemüller's map (1507, #*310*) next to Amerigo Vespucci – the geographer of the Old World facing the explorer of the New. More recently, in the writings of human geographers, we find Ptolemy featuring as the forerunner of modern "scientific" representations of space, or even as the forefather of quantitative geography and the geographic information system (GIS) (usually set side by side a more "humanistic" or "cultural" Strabo).

REFERENCES:

*Bagrow, L., *History of Cartography*, pp. 33 - 36.
*Brown, L., *The Story of Maps*, pp. 58 - 80.
*Chrysochoou Stella A., "Ptolemy's Geography in Byzantium"
*Crone, G.R., *Maps and Their Makers*, pp. 65 - 73.
*Dilke, O.A.W., *Greek and Roman Maps*, pp. 27, 35, 71-86,154-166,170.
Diller, A., The Oldest Manuscripts of Ptolemaic Maps", *Transactions and Proceedings of the American Philological Association* 71.
*Fite & Freemen, *A Book of Old Maps. . .*, pp. 1- 4.
Harvey, P.D.A., *Medieval Maps*, p. 54.
Nordenskiöld, A.E., *Facsimile Atlas*, pp. 1 - 29.
Shcheglov, Dmitry A., (2017) "Eratosthenes' Contribution to Ptolemy's Map of the World", *Imago Mundi*, 69:2, 159-175.
Schnabel, Paul, "Die Entstehungsgeschichte des kartographischen Erdbildes des Klaudios Ptolemaios', Sitzungs- Berichte der Preussischen Akademie der Wissenschaften, *Philologisch-historische Klasse* 14 (1930): 214–50
*Shirley, R.W., *The Mapping of the World,* entries 9, 10 and 11, Plate 20.
Sidiropoulos, G. and D. Kalpakis, "The Mountains of the Moon: A Puzzle of the Ptolemaic *Geography", 2014.*
Stevens, E., *Ptolemy's Geography.*
*Talbert, R.J.A., Alexander Jones, *Ancient Perspectives*, pp. 109-128.
*Tooley, R.V., *Maps and Mapmakers*, pp. 6 - 7.
Tudeer, L.O., "On the origin of the Maps Attached to Ptolemy's Geography", *JHS 37.* 1917, 62-76
*Woodward, D., *Art & Cartography*, pp. 13, 35, Figures 1.2, 1.18, Plate 16.
Wurm, Antonin, *Rozbor Ptolemaiovy osmemapy Asie* (Chotebor, B. Styblo, 1926)
*illustrated

Images:

119 Ptolemaic world map 1505
119 Ptolemaic world map, 12th-13th century
119A Ptolemaic world map in the *Liber Chronicarum* 1493
119A1 Ptolemy on Waldseemüller's world map of 1507
119B* Ptolemaic world map in the *Liber Chronicarum* 1493
119C Ptolemy's conic projection (100 A.D.)
119C1 Ptolemy's conic projection (100 A.D.)
119D Ptolemaic world map 15th century
119D1 Ptolemaic world map 13th century
119E Ptolemaic Western Europe
119F Ptolemy's regional divisions (100 A.D.)
119F1 Ptolemy's Instructions (100 A.D.)
119G Ptolemy's modified spherical projection 1561
119G Ptolemy's modified spherical projection modern
119G1 Ptolemy's modified spherical projection (100 A.D.)
119H Ptolemy's map superimposed on Mercator
119I Ptolemy's Ulm Edition 1482
119I1 Ptolemy's Ulm Edition 1482
119J Ptolemy regional map, *Tabula Asia*

LIST OF VARIOUS EDITIONS OF PTOLEMY'S *GEOGRAPHIA*

1475 (folio) Vicenza. Hermanus Levilapis [Hermann Lichtenstein]. First edition. Issued without maps. Translated by J. Angelus, edited by Angelus Vadius and Bernardus Picardus. 144 leaves.

1477 (folio) Bologna. 26 copper-plate maps. First engraved atlas in the world, the rarest and most valuable edition of Ptolemy. Translated by J. Angelus, with corrections by Beroaldus and others, edited by Angelus Vadius. 61 leaves, 26 maps, first leaf a blank. The atlas is misdated 1462.

1478 (folio) Rome. Arnoldus Buckinck. 27 copper-plate maps. Translated by J. Angelus, emendations by D. Calderinus. 70 leaves without title, signatures or pagination, last leaf blank. 27 maps.

1482 (folio) Florence. Nicolo Todescho. 31 copper-plate maps. The first atlas to attempt the introduction of modern geography. Four new maps—France, Italy, Spain and Palestine—being based on contemporary knowledge. The text is a metrical paraphrase by Francesco Berlinghieri, and is the first edition in Italian. It is also the only edition with maps printed on the original projection with equidistant parallels or meridians. Nordenskiöld dates this edition 1478, giving it priority over the Roman edition.

1482 (folio) Ulm. Leonardus Hol. 32 wood-cut maps. The first edition to be printed in Germany, the first with wood-cut maps. The map of the world is the first to show contemporary discoveries, and the first map to bear the name of its engraver, Johannes Schnitzer de Armssheim. Five of the maps modern. One, the first to show a printed representation of Greenland. Translated by J. Angelus, edited by Nicolaus Germanus, who drastically revised the maps. 70 leaves, last blank, 32 maps. Some copies were printed on vellum, and there are variants of the text.

1486 (folio) Ulm. Johann Reger. 32 wood-cut maps. B.M. catalogue 1895 states the maps and type are the same as those of edition of 1482. There are, however, additions to the map of Germany in the 1486 edition. 140 leaves(117 and 124 blank), 32 maps.

1490 (folio) Rome. Petrus de Turre. 27 copper-plate maps. Second Rome edition with the same maps as the 1478 edition. 120 leaves (1, 36, 37, 98 and 120 blank), 27 maps.

1507 (folio) Rome. Bernardus Venetus de Vitalibus. 33 copper-plate maps. 27 of the maps are re-issues of the Rome editions of 1478 and 1490. The other 6 maps—northern Europe, Spain, France, Poland, Italy and the Holy Land—are based on contemporary knowledge.
127 leaves, 33 maps.

1508 (folio) Rome. Bernardus Venetus de Vitalibus. 34 copper-plate maps. A re-issue of the preceding, but with a new title-page, an account of the New World by Marcus Beneventanus, and a new map of the world by Ruysch, Nova Tabula. This is the first map in any edition of Ptolemy to show the New World. 141 leaves, 34 maps.

1511 (folio) Venice. Jacobus Pentius de Leucho. 28 wood-cut maps. The heart-shaped map of the world is the first in an edition of Ptolemy to show a printed delineation of part of the North American continent. Translated by Angelius, with annotations by Sylvanus. Some copies are printed on vellum.

1513 (folio) Strasburg. Johannes Schott. 47 wood-cut maps. The most important edition of Ptolemy, containing the 27 maps of the ancient world and 20 maps based on contemporary knowledge, under the superintendence of Martin Waldseemüller. Includes the *Tabula Terra Nova*,

the first map specifically devoted to the delineation of the New World. The greatly increased number of "modern maps" makes this in effect the first modern atlas.

1514 (folio) Nuremberg. Johannes Stuchs. No maps. New translation by Joannes Werner.

1520 (folio) Strasburg. Johannes Schott. 47 wood-cut maps. Maps as in 1513 edition from the same blocks, except Switzerland.

1522 (folio) Strasburg. Joannes Gruninger. 50 wood-cut maps. Reduced versions of 1513 edition plus three new maps compiled for this edition. World by Laurent Frisius; Tab. Mod. Orientalis; Tab. sup Indiae et Tartariae Majoris.

1525 (folio) Strasburg. Joannes Gruninger. 50 wood-cut maps. Maps, with the exception of Asia V, printed from the same blocks as 1522 edition, and like them almost unaltered copies on a reduced scale of the maps of the 1513 edition.

1533 (quarto) Basle. Hieronymus Froben. Maps are the same as in the preceding edition.

1596 (quarto) Venice. Heirs of Simone Galignani de Karera. 64 copper-plate maps. A new edition with new maps (by H. Porro).

1597 (quarto) Cologne. Petrus Keschedt. 64 copper-plate maps. Maps are the same as in the 1596 edition.

1597-8 (folio) Venice. G. B. and G. Galignani. 64 copper-plate maps.

1598-9 (quarto) Venice. Heirs of Melchoir Sessa. 69 copper-plate maps. Italian text. Maps are the same as in the editions of 1561, 1562, 1564 and 1574 re-worked.

1602 (folio) 34 copper-plate maps. Dusseldorf.

1605 (folio) Amsterdam (also at Frankfurt). Cornelius Nicolaus and Jodocus Hondius. 28 copper-plate maps. The first edition to have Greek and Latin text together. The maps are the same as in the editions of 1578 and 1584.

1608 (quarto) Cologne. Petrus Keschedt. 64 copper-plate maps. Maps are the same as in the editions of 1596 and 1597.

1617 (quarto) Arnheim. Joannes Jansson. 64 copper-plate maps. Maps are the same as in the editions of 1596,1597 and 1608.

1618-19 (folio) Leyden. Elzevier, Amsterdam Hondius. 47 copper-plate maps. Greek and Latin text in parallel columns. The maps are taken from Mercator's editions of 1578, 1584 and 1605, and from various editions of Ortelius's Theatrum

1621 (folio) Padua. Brothers Galignani. 64 copper-plate maps. Maps are the same as in the edition 1597-8.

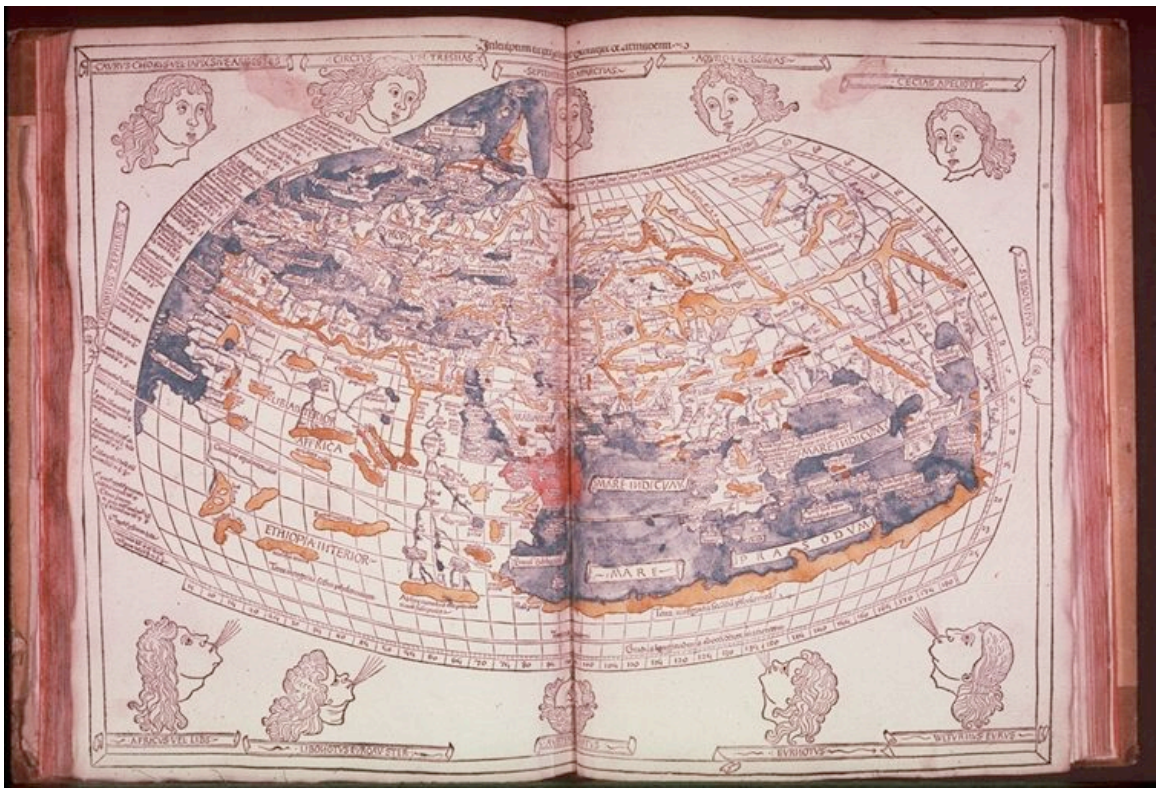
1695 (folio) Franeker & Utrecht. 28 copper-plate maps. No text. A re-issue of Mercator's Maps, 1578.

1698 (folio) Re-issue of the preceding.

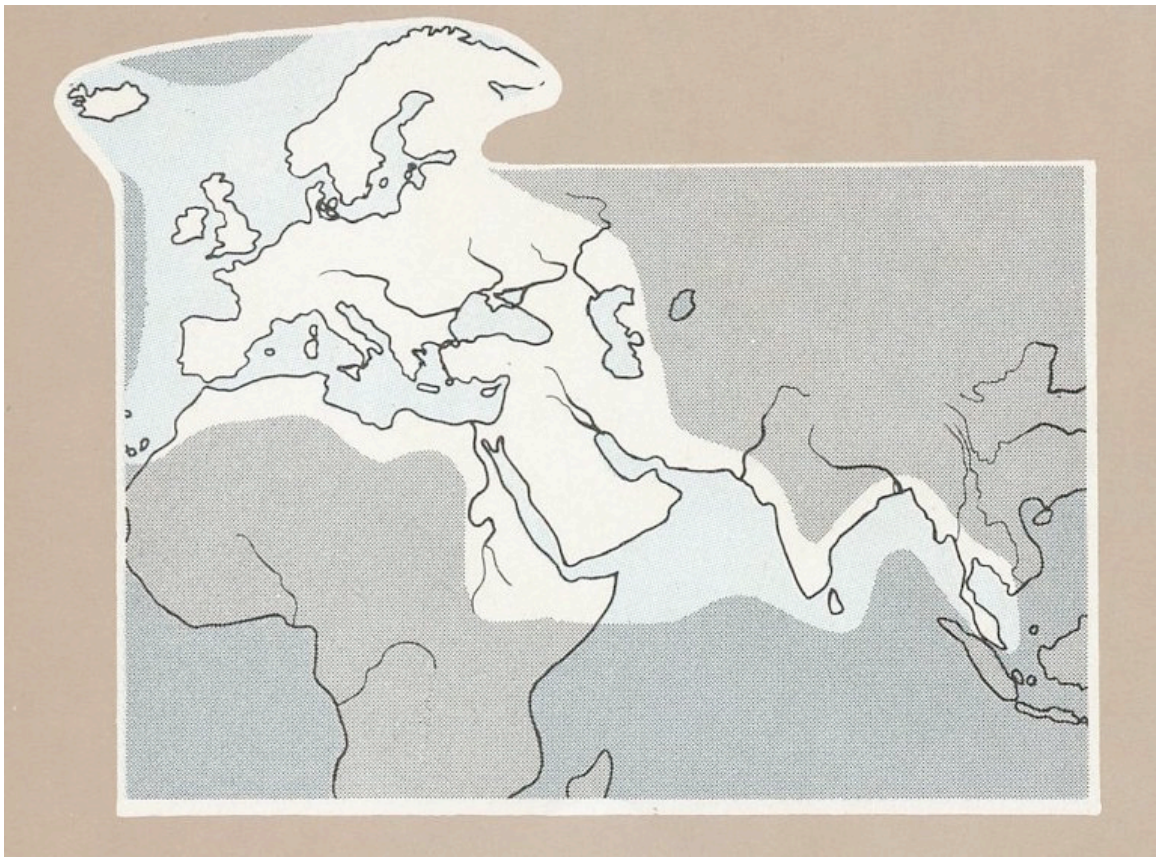
1704 (folio) Amsterdam & Utrecht. 28 copper-plate maps. Re-issue of the editions of 1695 and 1698.

1730 (folio) Amsterdam. 28 copper-plate maps. Re-issue of editions of 1695,1698 and 1704.

1828 (quarto) Paris. Greek and French text. Translation by Abbe Halma.



Ptolemy's world map in the Ulm edition, 1482

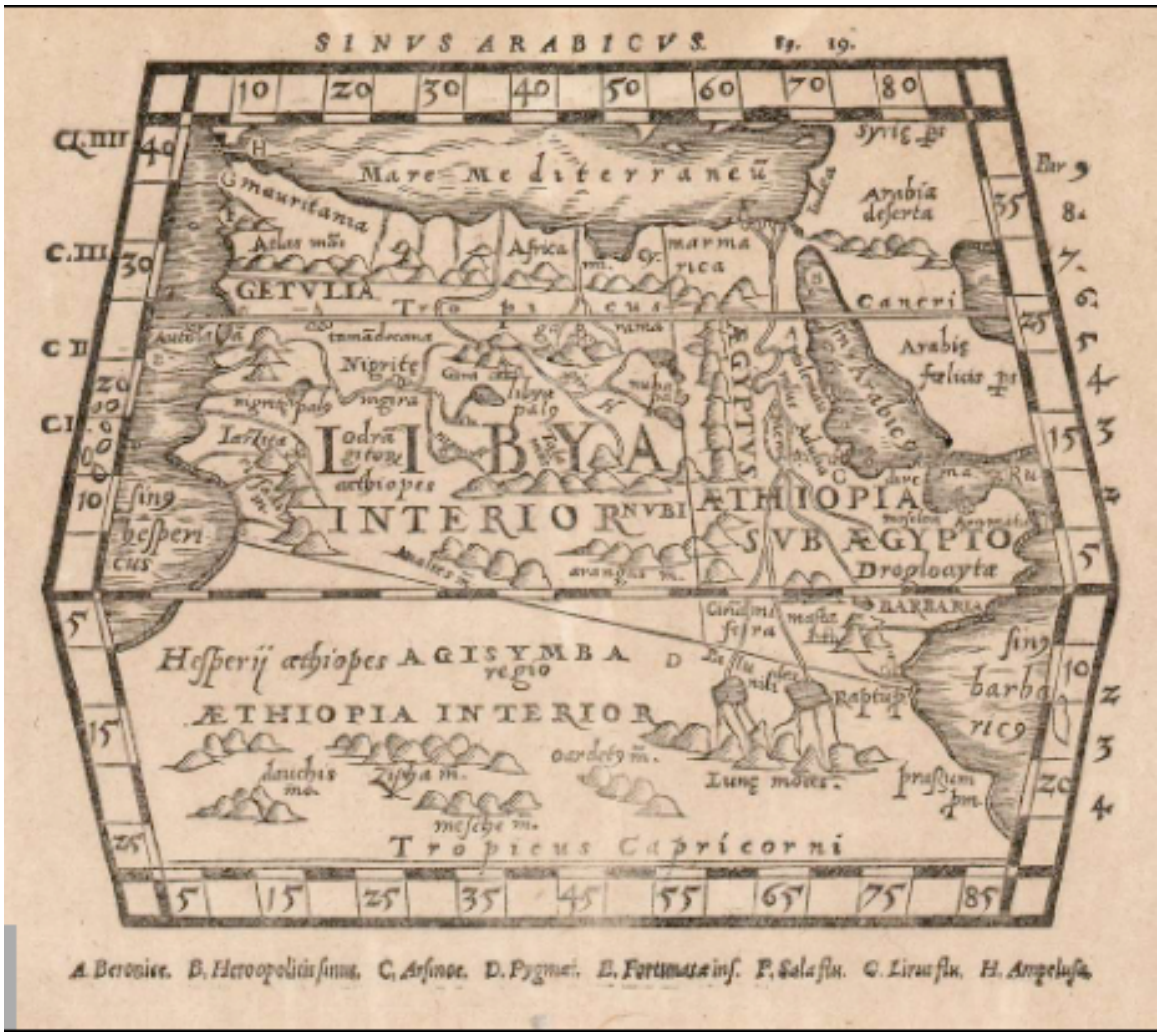


The area covered by Ptolemy's world map superimposed on an outline of a modern map

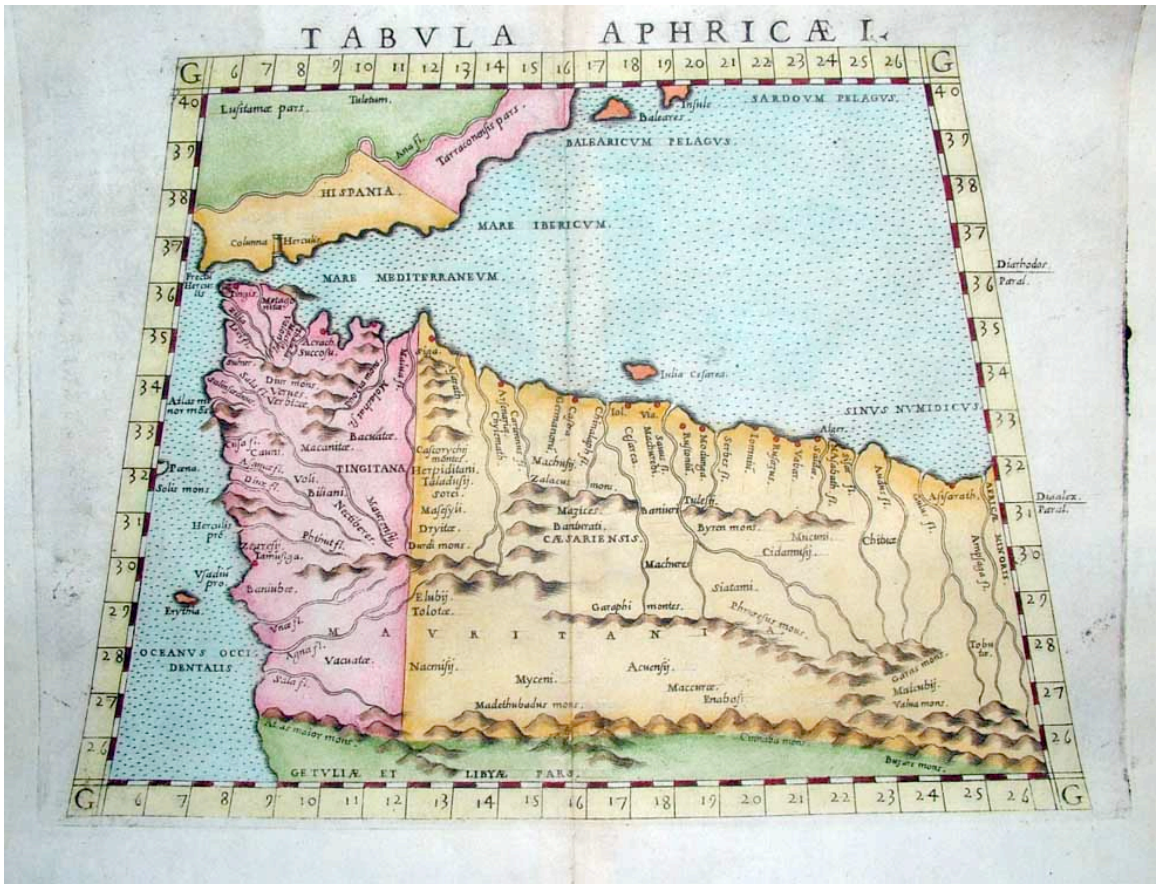

TABVLA ASIAE VIII
SCYTHIA
SERICA
SCYTHIA EXTRA
IMAVM
SACA
INDIA
intra Gangem
INDIA
extra Gangem
SINA
regio

A map of Africa by Girolamo Ruscelli, published by Girodano Ziletti, Venice, 1574

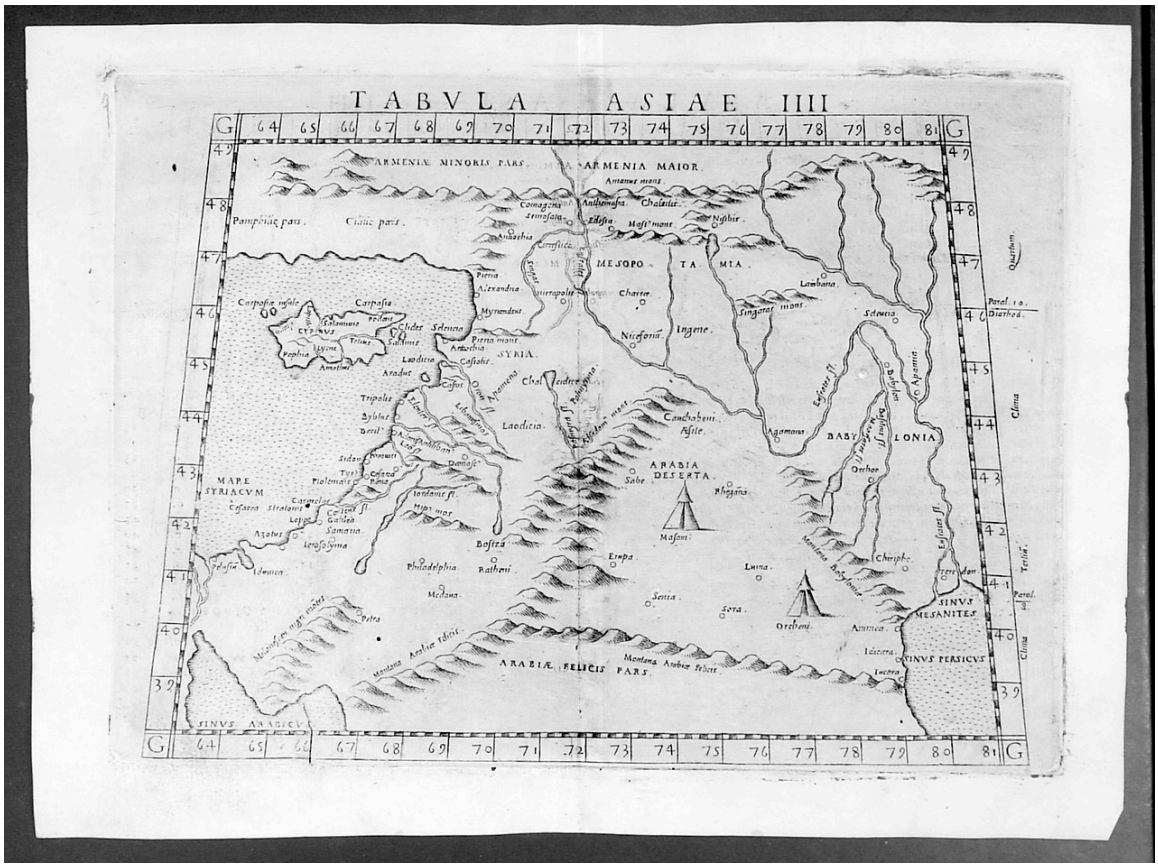
A map of Saudi Arabia by Girolamo Ruscelli, published by Girodano Ziletti, Venice, 1574



This Ptolemaic map of Africa was printed in 1576 by Heinrich Petri to illustrate his edition of Pomponius Mela's *De orbis situ, libri III* and Iulius Solinus' *Polyhistor,*.



A map of northwest Africa by Girolamo Ruscelli, published by Girodano Ziletti, Venice, 1574


TABVLA ASIAE IIII
ARMENIÆ MINORIS PARS
ARMENIA MAIOR
MESOPO TA MIA
SYRIA
ARABIA DESERTA
BABY LONIA
MARE SYRIACVM
ARABIÆ FELICIS PARS
SINVS ARABICVS
SINVS PERSICVS
SINVS MESANITES

World. PTOLEMY, C. [Rome, 1478] Untitled Copperplate-Engraved World Map. 12x21 inches. Two joined sheets, mounted on old paper; manuscript title in upper margin in an early hand, untrimmed example.

This very rare first edition of what can be regarded as the first acquirable, true map of the world. It was preceded only by the essentially unacquirable map from the 1475 *Rudimentum Novitiorum (#253)*, itself a crude, medieval construction, and the 1472 Isidorus T-O map (#*205*), which is no more than a diagram. The world map from the 1477 Bologna edition of Ptolemy can be considered unacquirable. Not only is this example a true 1478 edition as validated by the crossbow within a circle watermark on the paper, but it is also altogether uncropped with ample margins on the sides, which is very rarely the case with this map, regardless of edition.

While historically somewhat overshadowed in the map collectors' community by the more decorative variations of the other early Ptolemaic world maps, this Rome edition has been widely judged to be the most accomplished of all the early Ptolemaic world maps. In fact, most scholars feel that in regard to both geographic sophistication and quality of design and printing, the Rome edition was not exceeded until Mercator's definitive edition, published much later in 1578. Also, among the early editions of Ptolemy, only the Rome edition has a documented and significant connection to Christopher Columbus. He is known to have owned an annotated copy of the 1478 Ptolemy atlas, and Ptolemy's considerable underestimation of the earth's circumference, which is visually expressed on this map, supported Columbus' argument that one could reach the East Indies with relative ease by sailing west.

The Rome edition of Ptolemy was also an important landmark in the history of printing. One of its printer/publishers, Conrad Sweynheym, set up the first press in

Italy in 1464. (Sweynheym died in 1477, and the work was published under the imprint of his partner, Arnold Buckinck.) It is believed that work on the project began in 1474 or even earlier, so that the plates were most likely prepared prior to those of the 1577 Bologna edition, which is considered the earliest printed Ptolemy by virtue of publication date alone. Moreover, the Rome edition is regarded as the vastly superior work. The famous cartographic historian R. A. Skelton argues that the Rome edition was finer in all respects: fidelity to Ptolemy's text and quality of both engraving and printing. "The cleanness and precision with which geographical details are drawn; the skill with which the elements of the maps are arranged according to their significance, the sensitive use of the burin in working the plates-these qualities, in strong contrast to the careless design and crude cutting of the Bologna maps, seem to point to the hand of an experienced master" - Skelton. He further suggests that its superiority as a printed object was due to the greater skills of the printers. He points out that printing from a copperplate as opposed to from movable type was still a new process at the time in Italy, and that Sweynheym was one of the few who had mastered it.